Nonlinear Regimes of THz Generation from Metallic Surface Irradiated by Femtosecond Laser Pulses

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Terahertz radiation form metal surface irradiated by femtosecond optic pulses is a quite new area of pulsed terahertz generators research. In most of works the process of THz generation is discussed for low femtosecond pulse fluence [1-2]. In this work we report numerical results on THz generation form metallic surfaces irradiated by femtosecond laser pulses for high fluence of optic pulse.

Recently in IAP RAS it was experimentally shown that efficiency of terahertz generation drops significantly with increase of incident laser pulse fluence. In experiments laser pulse was focused onto metal surface and the distance between lens and surface was varied. Just before bulk ionization of air above metal surface efficiency significantly drops. For interpretation of this effect we investigated nonlinear dynamics of *p*-polarized femtosecond pulse incident obliquely onto metal surface. We characterized metal by cold electron plasma permittivity. The model of air ionization was chosen to be of tunnel type according to our previous investigations of air-plasma terahertz generation [3]. In the vicinity of the surface laser field almost doubles (see Fig. 1a) this leads to formation of plasma in the vicinity on surface (see Fig. 1b), which screens femtosecond pulse.

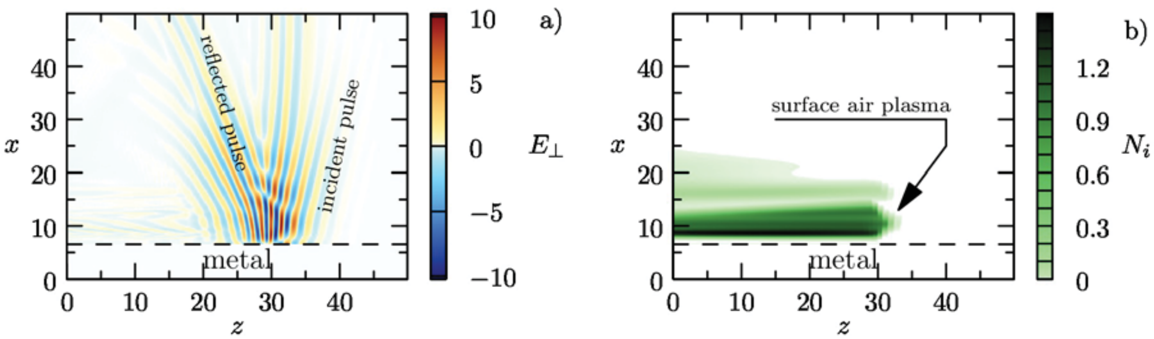

Fig. 1. Femtosecond laser pulse refracting from air-metal boundary a) – orthogonal electric field distribution, b) – air plasma distribution. All values are in arbitrary units.

In order to calculate THz radiation energy we used an approach, which is quite similar to one used in theory of SHG from metal. In the model of free electrons we managed to calculate the source of low frequency surface current and near-field THz Cherenkov radiation for *p*-polarized laser pulse.

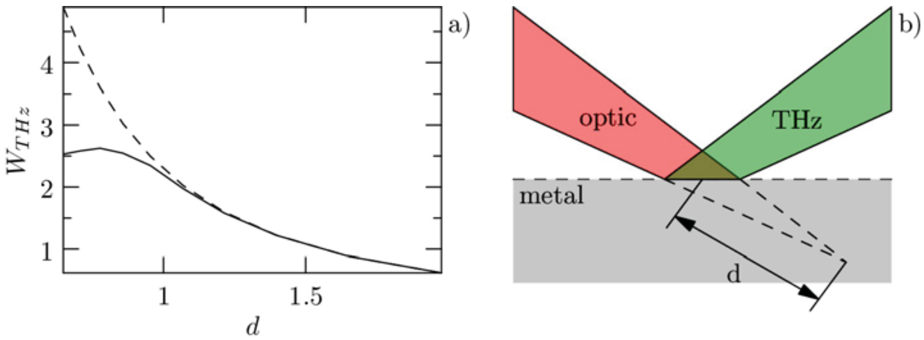

Fig. 2. Decay of terahertz generation efficiency with respect to distance between focal spot and metal surface, solid curve represents calculations considering air-plasma, dashed curve corresponds to absence of plasma – a); scheme of experiment – b). All values are in arbitrary units.

We calculated THz energy for different distances *d* (see Fig. 2b) between imaginary focal spot and metal surface corresponding to different incident fluence (see Fig. 2a). It is clearly seen that our model interpret the decay of THz generation efficiency for intesities of incident optic pulse high enough for optical breakdown of air in thin layer above metal surface.

References

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